25 drawings

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COPYING SYSTEM

FIELD OF THE INVENTION

The present invention relates to a copying system which reads a manuscript picture by resolving the picture into pixels and forms an image thereof on recording paper.

BACKGROUND OF THE INVENTION

There have been proposed various types of copying system which reads a manuscript picture by resolving the picture into pixels and forms an image thereof on recording paper. One of the typical copying systems is a digital copying machine. A digital copying machine is largely divided to a scanner section which reads a manuscript picture by resolving it into pixels and a printer section which outputs the image data read as described above onto recording paper, and these scanner section and printer section are integrated and packaged in a housing.

In a conventional type of digital copying machine, logic architecture in the copying machine has been fully modularized, but the copying function is achieved for the first time when the scanner section and the printer section are physically integrated.

On the other hand, in recent years, in association with the progress in the fields of image processing technology and communication control

technology as well as with development of various types of image forming apparatus, a copying system has been developed which can be used as a copying machine by assembling such component devices as a scanner, a printer, and a computer each developed as an independent product and outputting image data read with the scanner in the printer.

However, the conventional type of digital copying machine is an integrated type of copying machine formed by integrating and packaging a scanner section and a printer section in a housing, so that there are problems as described below.

Firstly, although a size of copying machine has largely been reduced, a size and weight of general copying machines excluding ones for personal use are still fairly large, so requests from sellers and disposers for, for instance, reduction of the unit weight in transportation can not easily be satisfied.

Secondly, it is necessary to integrate all components in a factory, which prevents improvement of the production efficiency by distributing production sites and assigning specific tasks to each production site.

Thirdly, even if it is necessary to improve the copying machine partially or to partially change the design thereof, change of the entire production process for the coping machine is required, so that improvement or change of design is difficult, which in

turn makes it difficult to take a quick response to social needs.

Fourthly, to satisfy various needs of users as well as to optimize the production and distribution cost, there is no way but to incorporate as many functions as possible in a few types of copying machine, sometimes a copying machine has odd and unnecessary functions for specific users, so that the users have no way but to buy the expensive copying machines. Also it has been impossible to upgrade a copying machine by changing only a portion thereof.

Fifthly, when a fault section which can not be repaired is generated in a portion of the copying machine, it is necessary to buy a new copying machine even though the remaining portion is available, which increases burden of cost to users.

On the other hand, in case of copying machine formed by assembling such components as a scanner, a printer, and a computer each developed as an independent product, it is possible to alleviate the first to fifth problems described above, but because of the problems as that the cost of the entire system becomes higher as compared to that of an integrated type of copying machine, that a large space is required for installation, that the operability becomes lower, that a buffer memory is required, and that the first copy time becomes longer, the copying machine can not be compared to an integrated type of copying machine,

and it can not be used in place of an integrated type of copying machine.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a copying machine having the same operability and economical advantages as those of the integrated type of copying machine, to reduce a unit weight, to distribute production sites and assign a specific production process to each production site, to easily improve or change a design thereof, to reduce or eliminate production cost for unnecessary functions, to upgrade the system by partially changing it, and to reduce burden of cost to users when a fault section which can not be repaired is generated therein.

In the copying machine according to the present invention, an image reading means in a scanner module resolves a manuscript picture into pixels according to a command from a system control module integrated with a scanner module or a printer module, and the first synchronizing signal generating means synchronizes to a first frequency signal and outputs image data through a first data I/O means to outside of the scanner module.

A printer module, which is separated from the scanner module, synchronizes to a second frequency signal generated by a second frequency signal generating means and fetches the image data from a

second I/O means, and an image forming means forms permanently visual image on a recording medium based on the image data.

For this reason, it is possible to produce, check, and ship the scanner modules and printer modules independently, and also it is possible to reduce a unit weight for transportation by packing the modules by a small lot and also to deliver the modules to users through an independently distribution channel respectively. Also a new copying machine can be realized by assembling the two modules, and if life of one of the modules is out, it is possible to abort only the module and to replace it with a new one, and also it is possible to reassemble a system at an appropriate cost according to change of work load.

Also each module is arranged at a specified position with an arranging means, and data is transferred by means of light, electric waves, or supersonic waves and without using such a means as cable to the modules arranged at a specified position respectively. For this reason, troublesome works such as wiring are not necessary, and the workability in setting each module is remarkably improved.

As described above, the copying system according to the present invention comprises an image reading means for reading a manuscript picture by resolving it into pixels, a first data I/O means which is an I/O interface for image data as well as for

various types of control data, a first electric power supply means for supplying an electric power, and a first synchronizing signal generating means for generating a first frequency signal, a scanner module formed as an independent frame, an image forming means for forming and outputting the image data as a permanent visual image on a recording medium, a second data I/O means which is an I/O interface for image data as well as for various types of control data, a second electric power supply means for supplying an electric power, a second synchronizing signal generating means for generating a second frequency signal, a printer module formed as an independent frame, a third data I/O means which is an I/O interface for image data and various types of control data, a system control means for issuing commands to run the scanner module and the printer module synchronously, and a system control module formed as an independent frame, so that said copying system has the functions, operability, and economical characteristics equivalent to those of an integrated type of copying machine, makes it easier to eliminate or reduce cost for unnecessary functions or to upgrade the system by changing a portion of the system, and also to reduce cost for users when a faulty section, which can not be repaired, is generated.

Other objects and features of this invention will become understood from the following description

with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram illustrating basic components of a copying system according to the present invention;

Fig. 2 is a block diagram of a scanner module;

Fig. 3 is an organization chart illustrating mechanism of a scanner module;

Fig. 4 is an explanatory view illustrating components of a first data I/O section;

Fig. 5 is a speed diagram of an image reading mechanism section;

Fig. 6 is a flow chart illustrating other functions of the first data I/O section;

Fig. 7 is a block diagram illustrating basic functional sections of a printer module;

Fig. 8 is an organization chart of the printer module;

Fig. 9 is an explanatory view illustrating components of a second data I/O section;

Fig. 10 is an explanatory view illustrating an example of timing control for the printer module;

Fig. 11 is a flow chart illustrating other functions of the second data I/O section;

Fig. 12 is a block diagram illustrating basic

functional sections of a system control module;

Fig. 13 is an organization chart of the system control module;

Fig. 14 is an explanatory view illustrating components of a third data I/O section;

Fig. 15 is a flow chart illustrating functions of a copying process section in a system control section for achieving the copying function;

Figs. 16A and 16B are timing charts for copying operation;

Fig. 17 is a timing chart for a case when any trouble occurred during copying operation;

Figs. 18A, 18B and 18C are explanatory views illustrating an example of system configuration in which 3 types of basic module are assembled;

Figs. 19A and 19B are explanatory views illustrating another example of system configuration in which 3 types of basic module are assembled;

Fig. 20 is an explanatory view illustrating a concrete example of system configuration as a copying system;

Fig. 21 is an explanatory view illustrating functional sections and a signal flow in the concrete example shown in Fig. 20;

Fig. 22 is an explanatory view illustrating timing for copying a color picture in the copying system shown in Fig. 20;

Fig. 23 is a block diagram illustrating basic

components of the copying system according to the present invention;

Fig. 24 is an explanatory view illustrating configuration for sending and receiving data by means of light through a space according to the present invention;

Fig. 25 is an explanatory view illustrating configuration for sending and receiving data with electric waves through a space according to the present invention;

Figs. 26A and 26B are explanatory views illustrating an arranging means (based on a screw system) according to the present invention; and

Fig. 27 is an explanatory view illustrating an arranging means (based on a hook system) according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Description is made hereinafter for an embodiment of the present invention in the following order with reference to the related drawings.

[Basic components]

[Configuration and operation of a scanner module]

[Configuration and operation of a printer module]

[Configuration and operation of a system control module]

[Examples of combination of each module]

[Concrete examples of copying system]

[Basic components]

Fig. 1 is a block diagram illustrating basic components of a copying system according to the present invention. The copying system according to the present invention comprises three basic modules; a scanner module 100, a printer module 200, and a system control module 300.

The scanner module 100 has at least an image reading section 101 for reading a manuscript picture by resolving it into pixels, a first data I/O section 102 which is an I/O interface for image data and various types of control data, a first electric power supply section 103 for supplying an electric power, and a first synchronizing signal generating section 104 for generating a first frequency signal, and is formed as an independent frame. It should be noted that a basic image processing section 105 and an extended image processing section 106 not shown herein but described later according to the necessity are added.

The printer module 200 has at least an image forming section 201 for forming and outputting image data as a permanent visual image on a recording medium, a second data I/O section 202 which is an I/O interface for image data and various types of control data, a second electric power supply section 203 for supplying an electric power, and a second synchronizing signal

generating section 204 for generating a second frequency signal, and is formed as an independent frame. Herein, the image forming section 201 is a name given to an assembly of a plurality of means as described below for convenience. It is assumed that the image forming section 201 includes so-called the image forming components such as a photo-sensitive drum 205, an electrifying scorotron 206, a laser exposure unit 207, a developing unit 208, primary transfer corotron 209, an intermediate transfer belt 210, and a secondary transfer corotron 211.

The system control module 300 has at least a third data I/O section 301 which is an I/O interface for various types of control data, and a system control section 302 which issues commands for running the scanner module 100 and the printer module 200 in synchronous mode, and is formed as an independent frame. However, it is desirable that the frame of system control module is monolithically formed with a frame of scanner module 100 or a frame of printer module 200.

These three basic modules can satisfy system functions even if they are structurally separated from each other as shown in Fig. 3, Fig. 8 and Fig. 13. In this embodiment, to satisfy the requirements of reducing a unit weight during transportation and simplifying system assembly, the scanner module 100 is packed by frame as the unit, while the printer module

200 is packed together with the system control module 300 mounted on and fixed thereto, when shipped from a factory.

Furthermore, in the embodiment, considerations are taken for convenience in use when the basic modules are assembled, beauty in appearance, users' convenience such as space efficiency, and technological problems such as prevention of electromagnetic emission, noise immunity, heat emission, mechanical resonance. For instance, when building a copying system, at least the above 3 basic modules and a table (or a selectable multi-stage paper feeder) are assembled, and it is preferable to pile up the components in the vertical direction for higher space efficiency, and also a height of a platen should preferably be in a range from 900mm to 1100mm for better operability in mounting a manuscript. Also various types of operation buttons should preferably be arranged on the same plane as the platen surface or at a little lower level as compared to the level of the platen surface level to realize an excellent human interface.

To satisfy the requirements as described above, in the copying system according to the present invention, a plane of projection of each basic module's surface for piling up is almost identical to eliminate ill-shapedness when the basic modules are piled up and prevent the modules piled at higher positions from

falling down and so that the positional relation between the platen and the surface of the operating unit when piled up will be as described above. Also from viewpoints of good appearance and safe electromagnetic environment, a number of cables used for connection between the basic modules has been reduced as much as possible, and the positions of terminals are arranged so that a length of cable between terminals is as short as possible. When it is necessary to realize only a copying function, the system control module 300 can be built with an extremely compact configuration, so that the system control module 300 can be incorporated as parts of other module. In that case, the considerations as described above are required only in relation to the positional relation between the 2 modules to be integrated, which is within a scope of this invention. Description is made hereinafter for configuration and operation of each module one by one.

[Configuration and operation of the scanner module]

Fig. 2 is a block diagram illustrating basic functional sections of the scanner module 100. The scanner module according to the present invention comprises an image reading section 101 to read a manuscript picture by resolving it into pixels as described above, a first data I/O section 102 which is an I/O interface for image data and various control data, a first power supply section 103 to supply an

electric power, a basic image processing section 105, and an extended image processing section 106. It should be noted that, in this embodiment, a first synchronizing signal generating section 104 is arranged in the first data I/O section 102. All of these components are packaged in the scanner module 100.

The image reading section 101 comprises a color imaging device 101a, an analog/digital convertor (described A/D convertor hereinafter) 101b, a shading correction circuit 101c, and a sampling displacement compensation circuit 101d.

The first data I/O section 102 has a plurality of SCSI connectors 102a, 102b each having the same form as well as the same interface, optical fiber connectors 102c, 102d for communications with a scanner optionally added device, and a first synchronizing signal generating section 104.

The basic image processing section 105 comprises a space filter circuit 105a, a multiplying circuit 105b, a color processing circuit 105c, a tone processing circuit 105d, an image adding circuit 105e, an image area auto-separating circuit 105f, a color manuscript auto-detecting circuit 105g, and a securities detection circuit 105h.

Therein the space filter circuit 105a executes operations for smoothing and/or sharpening. Generally, when a manuscript G is a screen tone printed material, the former processing is carried out, and

when the manuscript G consists of only letters, the latter processing is carried out. Selection is inputted from a manuscript select screen such as a console, or is automatically made according to a result of separation in the image area auto-separating circuit 105f.

The multiplying circuit 105b changes a size of an image by 25% to 400% in the primary scanning direction. It should be noted that a size of an image in the secondary scanning direction is changed by changing the image reading speed (secondary scanning speed).

The color processing circuit 105c has a function for masking manuscript picture RGB signals to convert the signals to C (Cyan), M (Magenta), Y (Yellow), and K (Black) image signals. Furthermore the color processing circuit 105c executes so-called the adaptive color processing in which an appropriate color processing is executed according to whether an image is a character image or a light and shade one, for instance, to convert a black letter section to a pure black image. Also the color processing 105c makes the RGB signals pass through the first data I/O section 102 as they are and outputs the signals to the system control module 300.

The tone processing circuit 105c executes a dither processing from any of 8-bit C, M, Y, K image signals to generate a 2-bit record image signal.

Furthermore the color processing circuit 105c executes an appropriate tone conversion for a character image and a light and shade image, which is so-called the adaptive tone processing.

The image adding circuit 105e generates small pattern data for tracing to prevent securities from being illegally copied and added the data to the manuscript picture data.

The image area automatically separating circuit 107f recognizes a character image section and a light and shade image section on a sheet of manuscript picture pixel by pixel, and outputs the result to the space filter circuit 105a, the color processing circuit 105c, and the tone processing circuit 105d.

The color manuscript automatically detecting circuit 105g executes a processing for discriminating a color manuscript from a monochrome manuscript.

The securities detecting circuit 105h makes a determination as to whether the manuscript G is any of securities inhibited to be copied or not.

The extended image processing section 106 comprises an area-specified image processing circuit 106a and an image editing circuit 106b. The extended image processing section 106 is provided near the scanner module 100 so that it can optionally be incorporated according to a user's needs.

Fig. 3 is an organization chart of the scanner module 100. In this figure, designated at the

reference numeral 103 is a first electric power supply section, at 103a a power supply plug for connection to commercial electric power, at 103b a power switch, at 107 a platen glass, at 108S a image tip reference position, at 108H a white board for correcting shading, at 108B a bar code for recognizing a solid object, at 109 a first carriage, at 110 a second carriage, at 111 a lamp for manuscript, at 112a to 112c first to third mirrors respectively, at 113 an image forming lens, at 114 an optical axis of the lens, at 115 a carriage home sensor, at 116 a manuscript picture scanning motor, and at 116a a driving wire. Also designated at 100S is a line for transferring data from the scanner module 110 to the system control module 300 or the printer module 200. It should be noted that the dotted line 400 in the figure indicates an automatic manuscript feeder which is incorporated according to a user's option.

Fig. 4 shows components of the first data I/O section 102. In this embodiment, control over communication with other modules is provided in this first data I/O section 102. In this figure, designated at 151 is a microprocessor (CPU), at 152 an interrupt controller, at 153 a read/write memory (RAM), at 154 a read-only memory (ROM), at 155 a timer counter (TMR), at 156 a DMA controller, at 157 a first-in first-out memory (FIFO), at 158 an SCSI controller, at 159 a controller for optical fiber connectors 102c, 102d, at 104a a crystal oscillator for the first

synchronizing signal generating section 104, at 102BUS a bus, and at 102D, 105D image data channels respectively. Also in this figure, the reference numeral 160 indicates an I/O circuit for such components as a sensor and a motor, while the reference numerals 400 and 410 indicates an automatic manuscript feeder and a film projector connected to each other through the optical fiber connectors 102c and 102d respectively.

Next description is made for functions of each section of the copying system having the configuration as described above in the following order:

1) Read operations of the scanner module
2) Operations of the basic image processing section
3) Operation controlling functions of the first data I/O section
4) Other functions of the first data I/O section
5) Operations of the extended image processing section

1) Read operations of the scanner module

The manuscript G is placed on the platen glass 107 with a surface to be copied faced downward and the read starting position aligned at the image tip reference position 108S at the left edge section of the plates glass. The image forming lens 113 forms an

image of the manuscript picture in a reduced side on a light receiving surface of the imaging device 101a. The imaging device 101a has a function to generate a color image with a charge coupled device, and an R image pickup section covered with a red filter in which 4752 pixels are arrayed one-dimensionally, a G image pickup section covered with a green filter in which 4752 pixels are arrayed one-dimensionally, and a B image pickup section covered with a blue filter in which 4752 pixels are arrayed one-dimensionally are arrayed in parallel to each other in the primary scanning direction (in the direction vertical to the plane of Fig. 3). The three scanning lines are close to each other, and concretely the space between each scanning line is 4/16mm on the manuscript picture plane. It should be noted that the direction for scanning by this one-dimensional imaging device is called primary scanning direction and the direction crossing the primary scanning direction at right angles is called secondary scanning direction.

The illuminating lamp 111 and the first mirror 112a are mounted on first carriage 109, while the second mirror 112b and the third mirror 112c are mounted on the second carriage 110. When reading a manuscript picture, the first carriage 109 and the second carriage 110 are driven at the secondary scanning speed Vsub and Vsub/2 respectively for scanning from the left edge to the right edge by the

manuscript picture scanning motor 116 and the driving wire 116a, without the optical conjugate relation between them being lost. It should be noted that the manuscript scanning motor 116 is a stepping motor.

The secondary scanning speed Vsub can be changed in a range from 1/8 to 4 times of the standard speed by 1 %, and the speed can be set to an appropriate level according to a command from other modules.

Next, description is made for an operation for scanning a manuscript picture with reference to the speed diagram for the image read mechanism section shown in Fig. 5. The first carriage 109 is usually positioned just under the carriage home sensor 115 and waiting for input of an instruction. Then output from the sensor 115 is ON. When the read scan instruction SCAN or REQ is received, the illuminating lamp 111 is turned ON at the timing t1, the motor 116 is driven, and scanning in the secondary scanning direction (rightward in the figure) is started. After the timing t2, the first carriage 109 goes off from an area for detection by the carriage home sensor 115, and the output is turned OFF. The going-off position is remembered as the scan reference position, which is used as a reference point for positional calibration. The first data I/O section 102 computes an optimal acceleration program for achieving a precision required for the timing t5 for arrival to the image tip

reference position 108S as well as for the speed Vsub, and also computes a step pulse series for the motor 116. The subsequent carriage speed is driven according to this pulse series, and the time required for reaching the image tip reference position 108S and a desired constant scanning speed can be obtained.

After passing the calibration reference point, the imaging device 101a reads images for each color projected through the lens 113 on the primary scanning line. This is convenient to stabilize the time required for accumulation of electric charge in the imaging device 101a to a constant level. The primary scan cycle is a pulse series cycle ts1 generated from the first synchronizing signal generating section 104, and the pulse series is connected through the bus 102BUS to the image reading section 101. It should be noted that the first synchronizing signal generating section 104 divides and outputs the original oscillation frequency of the crystal oscillator 104a to the bus 102BUS.

The total number of pixels in the imaging device 101a is 4752, and the imaging device 101a reads an original picture by resolving it to 16 pixels/mm in one primary scanning line and sampling the image, and outputs analog voltages corresponding to RGB reflected light by pixel from the manuscript picture. Then the analog voltage is converted to an 8-bit digital signal (namely quantized to any of 256 tones) by the A/D

convertor 101b, the signal being sent to a circuit in the next stage.

After passing the reference point above, the imaging device 101a reads the white reference board 108SH at the timing t3, which is converted to an 8-bit digital value and stored in the shading correcting circuit 101c. Then, shading correction is executed effectively to read image data. At the timing t4, when the first carriage 109 passes under the individual identification bar code board 108B for tracking illegal copy of securities as well as for remote service, the imaging device 101a read the image, and the image data is transferred to the system control module 300.

Then, when the first carriage 109 reaches the image tip reference position 108S at the timing t5, the image reading section 101 reads the manuscript picture by scanning line and successively outputs the image data as color resolution digital data for each image to the basic image processing section 105 in the next stage 105.

When the entire A3 size manuscript picture for 6720 scanning lines are read and the first carriage 109 reaches the right edge at the timing t6, the motor 106 is rotated in the contrary direction to return the first carriage 109 to the home position (position of the sensor 115), the first carriage 109 being stopped there to prepare for next scanning.

2) Operations of the basic image processing section

The RGB image data for the manuscript picture read as described above is inputted in parallel to the space filter 105a, the image area automatically separating circuit 105f, the color manuscript automatically detecting circuit 105g, and a securities detecting circuit 105h and processed therein in the basic image processing section 105 as shown in Fig. 2. Functions of the basic image processing section 105 can be divided to the following 2 categories. The first category is a function to support image processing in place of directly processing an image signal. Functions belonging to this category include an image area separating process for discriminating a character area from a gradated image area, a process for detecting a manuscript size, and a process for discriminating a color manuscript from a monochrome manuscript. Also the functions belonging to this category include a process in which the entire manuscript picture on the platen glass 107 must be checked such as a process for discriminating a color manuscript from a monochrome manuscript, and this type of processing is executed prior to forming a copy image, so that the processing is generally called prescan.

Functions belonging to the second category require processing of an image signal and include a processing with a space filter, image size changing,

image trimming, image movement, color correction, and tone conversion. The processes are further divided to those having the common processing contents in some image areas such as image size changing and those having different processing contents for a character image section and a light and shade image section (such as tone processing).

A result of processing belonging to the first category is in most case sent to the system control module 300. The system control module 300 receiving the result executes a process to form an image by issuing a control command according to the received result to other means. For instance, when the basic image processing section 105 determines that a manuscript picture is a monochrome one, the basic image processing section 105 sends a result of detection through the first data I/O section 102 to the system control module 300, and the system control module 300 sends a command such as K development energize, or CMY development stop to the printer module 200. Then, the second data I/O section 202 in the printer module 200 energizes only the K developing unit 208K described later and stops development with other colors to efficiently form an image.

Contents of a process belonging to the second category are divided to a case where the K developing unit 208K is automatically energized according to a result of processing belonging to the first category, a

case where an instruction is entered by an operator from a console, and furthermore to a case where the above 2 types of process are combined. As an example of these processes, a processing for deleting a specified color image is described later. In this processing, a specified color contained in a manuscript image is deleted, while other color images are stored to form an image on recording paper, and this processing is performed by the color processing circuit 105c in this basic image processing section 105. It should be noted that an instruction for specifying a color to be deleted is entered from a console by an operator.

In either type of processing, in the copying mode, RGB image signals inputted from the basic image processing section 105 are ultimately converted to signals for recording C, M, Y and K, and the data is transferred to the printer module 200.

It should be noted that a processing to convert the manuscript picture to a monochrome image is executed and 0 is outputted for signals other than K signal when it was determined that the manuscript was a monochrome one.

3) Operation control function of the first data I/O section

The first data I/O section 102 communicates with the system control module 300 or the printer

module 200 according to a specified protocol, controls the scanner module 100 for energizing for reading a manuscript picture, and outputs manuscript picture data. Also the first data I/O section 102 controls all of other means inside the scanner module 100 and an optionally added device such as an automatic manuscript feeder.

By the way, a general system in which the image reading section 101 and the image forming section 201 comprise a separate module respectively such as an optical filing system has a page buffer memory between the two components. In this type of configuration, However, a time lag is generated between the image reading step and the image forming step. This time lag results in a not-preferable result of increase of first copy time. To solve this problem, in this invention, a page buffer is eliminated to reduce the cost as well as to synchronize the image reading step to the image forming step, namely image reading and image forming are carried out without any substantial time lag. The synchronism between image reading and image forming has a dual sense; one is coincidence between cycles, and other is that between header phases.

If the synchronism can not be maintained, for instance, a fault such as an extended or shrunk copy image is generated in the former sense, and also a copy image position can not be reproduced correctly on

recording paper in the latter sense.

Furthermore, in the color copying system using a printer based on a system in which CMYK surfaces are successively formed as in this embodiment, the printer module 200 forms an image by successively superimposing CMYK images, but to realize a system which can be sold at a low price in the market, it is preferable to eliminate a page buffer memory, and in this step this it is referable that the scanner module 100 scans one sheet of manuscript 4 times in all and any of CMYK color images is sent each time the manuscript is scanned. For this reason, it is very important to maintain a accurate scanning position for a manuscript in successively scanning the manuscript 4 times in all, namely to maintain the synchronism. If this synchronism is lost, color print displacement occurs, and a correct color image can not be obtained.

Description is made for a system to achieve the objects as described above with reference to Fig. 5. The figure shows an operation flow in scanning a manuscript one time, and details of operation for scanning by 2 scanning lines are shown in the upper section. When the first carriage 109 receives the SCAN command from the system control module 300, the optical axis 114 of the first carriage 109 reaches the image tip reference position 108S in time t5 after the first carriage 109 received the command under control by the first data I/O section 102 as described above with the

secondary scanning speed adjusted to Vsub. With this feature, image data is always outputted in the constant time t5 after the command is received, so that at least the synchronism concerning phase is maintained. It should be noted that, to achieve the object as described above, the sensor 115 for detecting the carriage reference position is provided, the first carriage 109 is calibrated each time scanning is performed with reference to the scanning reference position, and at the same time the secondary scanning travel of the stepping motor (manuscript scanning motor) by 1 step angle is held under 1/16mm. As the motor driving system, such a system as a micro step driving system can be used.

Furthermore to establish synchronism concerning cycle, one primary scanning line is read in synchronism to the pulse series cycle ts1 generated by the first synchronizing signal generating section 104, and the data obtained through the scanning is sent to the FIFO 157. The side receiving the data (the scanner module 100 in Fig. 5) successively takes out the data at the substantially same cycle as the cycle ts1. In the copying mode, the printer module 200 receives the image data to maintain the cycle mechanism described above. For this reason, image data can be received in a constant time after a command is received irrespective of how many times a manuscript is scanned, and also a correct positional relation between paper

and an image (registration) can always be maintained. Furthermore a buffer memory is not required in color copy mode, correct registration of color print section is maintained, and a copy is outputted quickly.

It should be noted that the scanner module 100 basically receives the command described above from other 2 modules (system control module 300 and the printer module 200).

4) Other functions of the first data I/O section

Fig. 6 is a flow chart illustrating other functions of the first data I/O section 102. These functions are executed according to a program in the microprocessor 151 shown in Fig. 4. The program to be executed is stored in the ROM 154. The reference numeral S101 indicates an operation for turning ON the power switch 103b, while the reference numeral S102 indicates a processing for system initialization including setting initial parameters for various types of circuit element, watch dog timer start, and moving the first carriage 109 to the initial position.

The reference numeral S103 indicates a function to make a determination as to whether a command from the SCSI connectors 102a, 102b comes in at a specified timing (time-out time) or not.

The reference numeral S104 indicates a function to disconnect a power for the image reading section 101 and lower a supply voltage to the basic

image processing section 105 and the extended image processing section 106 to a limit allowing data storage in a resister in each circuit register, which contributes to reduction of power consumption in a stand-by mode and reduction of noise generated by a cooling fan.

The watch dog time out function indicated by the reference numeral S105 is generated when the watch dog timer is off from the normal execution mode, and at this point of time the fault generation alerting function indicated by the reference numeral S106 issues the watch dog time out signal to the system control module 300.

The reference numeral S110 indicates an interrupt vector when a fault is generated in either the basic image processing section 105 or the extended image processing section 106, and identification of the faulty section and analysis of causes for the fault are executed in S111, the result of operations above is sent to the system control module 300 in S112, and a fail-safe processing for preventing such troubles as fire is executed in S113, for instance, when the motor 116 goes wrong due to overheating.

The reference numeral S120 indicates an interrupt vector when any data is inputted to the SCSI connectors 102a, 102b, and at this point of time a sleep time is stopped in the step S121. In S122, contents of received data is checked, and system

operation is branched to any of the 5 operations as described below.

The first one is a path for making an inquiry as to whether the scan module 100 is ready for scanning a manuscript or not in TEST (TEST unit ready) indicated by the reference numeral S130, and a reply as to whether the scanner module 100 including optionally added devices 400, 410 is ready or not is given in S131.

S140 is the SENS (mode SENSe) function to make an inquiry as to various operating mode setup in the scanner module 100, and a reply as to the scanning mode currently set up on the scanner module 100 including the optionally added devices 400, 410 is given based on a result of processing in S141 to S145.

S150 is a path for SEL (mode SELect) request for requesting a mode to be set up in the scanner module 100, and this path forms a pair with the above SENS path. Various parameters are selected through each of the routines S151 to S156.

The reference numeral S160 indicates a path for issuing a SCAN or COPY request, and this request is issued once for one manuscript in ordinary monochrome processing, and in case of color processing the request is issued once in the RBG processing, while the request is issued 4 times successively in case of CMYK processing. When issuing this request, at first the motor 116 is driven in S161, passage of the first

carriage 109 is detected in S162 by monitoring with the sensor 115, and calibrating operation for resetting the position counter provided in the memory 153 is executed. This counter is incremented one by one according to a synchronizing pulse generated once for one scanning line from the first synchronizing signal generating section 104. In S163, a program for driving the motor 116 is computed so that the first carriage 109 reaches the image tip reference position 108S at a correct timing, namely in the time t5 after the SCAN or COPY request is received and also scanning will be executed at the scanning speed of Vsub set up according to the SEL request for mode selection.

Then the reference white board 108SH is read in S164, parameters for correction of shading are computed and set, and the results are used in shading correction of subsequently read image data. Then the individual identification bar code plate 108B is read in S165, control for accelerating rotational speed of the motor is provided in S167, and the control is switched to that for constant speed in S168 when the desired rotational speed is obtained. Monitoring as to whether a value provided by the counter indicates arrival of the first carriage 109 to the manuscript tip position or not is performed in S169, and the system control goes to S170 when the value indicates its arrival.

In S170, an entrance gate of FIFO 157 which

is a buffer memory for image data is opened to prepare for receiving image signals from the basic image processing section 105 through the image signal line 105D. The subsequent steps S171 to S174 are tasks each for sending manuscript picture data to the FIFO 157, and at first a synchronizing pulse generated by the first synchronizing signal generating section 104 for one scanning line is detected in S171. S172 is a step to store image data for 4752 pixels per scanning line through the image signal line 105D in the FIFO 157. Then, the carriage position counter is incremented in S173. In the step S174, this loop is repeated for the entire area of the manuscript picture; namely for instance, in case of A3 size, the loop is repeated for 6720 scanning lines (in other words 6720 times). When scanning for the entire area of one picture is over, the entrance gate of the FIFO gate 157 is closed in the step S175, a result of detection is received from the securities detection circuit 105h in the step S176, a result of color detection is received from the color manuscript automatically detecting circuit 105g in the step S177, and transaction of these data is executed through the bus 102BUS.

Then the motor is driven in the reverse direction in the step S178, a home is detected in the step S179, and operation of the motor 116 is stopped in the step S180. The sleep timer is activated in the step S123.

The reference numeral S190 indicates a route used when self DIAG (DIAGnostic) is requested to the scanner module 100, and this request is typically issued after the function to alert generation of a fault (the steps S106 and S107 described above), and the self diagnosis and a processing for issuing a reply to the request are executed in the steps S191 to S193.

5) Operations of the extended image processing section

The area-specified image processing section 106a has a function to execute a processing to an area of a manuscript picture specified by the operator which is different from that for other general area of the manuscript picture. Also the image edit circuit 106b has various types of function for processing an image including mosaicking, solarization, posterization, conversion to high contrast image, and conversion to line image to form an image subjected to specific effect.

Description is made below for an image trimming process which is one of the area-specified image processing as an example of the processing executed by the area-specified image processing circuit 106a. The image trimming is a process to duplicate a specified area of a manuscript picture and render the remaining portion to a blank space. The well-known technology (such as the technology disclosed in Japanese Patent Laid-Open No,159570/1987) can be used

for this processing. However, when using this technology, a marking must be given with a felt pen, and for this reason the manuscript may be damaged. To solve this problem, in this embodiment, a manuscript picture is read by the prescan, the image data is displayed, an operator enters instruction for specifying the trimming range watching the displayed image and using the cursor move key and the select key, and the specified area is rendered to a blank space by the area-specified image processing circuit 106a.

[Configuration and operations of the printer module]

Fig. 7 is a block diagram illustrating basic functional sections of the printer module 200. This module comprises the image forming section 201 to form and output image data as a permanent visual image on a recording medium, a second data I/O section which is an I/O interface for image data as well as for various types of control data, a second electric power supply section 203 for supplying an electric power, and a second synchronizing signal generating section 204 for generating a second frequency signal. Also in this embodiment, the second synchronizing signal generating section 204 for generating the second frequency signal is provided in the second data I/O section 202. The second data I/O section has a plurality of SCSI connectors 202a, 202b each having the same form and the same interface. All of these are packaged in the

printer module 200. The signs IN and OUT in the figure indicate the direction in which the recording paper is carried in and carried out respectively. It should be noted that, as described above, the image forming section 201 is a generic name for an assembly comprising so-called the image forming elements such as the light-sensing body drum 205, the electrifying scorotron 206, laser exposure unit 207, developing unit 208, primary transfer corotron 209, intermediate transfer belt 210, and secondary transfer corotron.

Fig. 8 is an organization chart of the printer module 200. In this figure, designated at the reference numeral 203 is a second electric power supply section, at 203a a power supply plug for connection to commercial electric power, at 203b a power switch, at 205 a photo-sensitive drum, at 206 an electrifying scorotron, at 207a laser exposure unit, at 208 an developing unit, at 209 a primary transfer corotron, at 210 an intermediate transfer belt, at 211 a secondary transfer corotron, at 212 an F0 lens, at 213 a rotational multi-faced mirror, at 214 a mirror, at 215 a cassette for automatically feeding paper, both sides of which is available for copying, at 216 a manual paper feed tray, at 217 and 218 a paper feed roller respectively, at 219 a resist roller pair, at 220 a cleaning unit, at 221 a transfer belt, at 222 a fixing roller, at 223 a fixing backup roller, at 224 a paper discharge roller, at 225 a discharge switching roller,

and at 226 an image tip position detection sensor (calls tip detection sensor hereinafter). Also designated at the reference number 227 is an external inlet port for carrying in recording paper from an option device. It should be noted that the developing unit 208 is an assembly of developing units incorporating a cyan developing unit 208C, magenta developing unit 208M, a yellow developing unit 208Y, and black developing unit 208K therein. The reference number 100S indicates a line for transferring data from the scanner module 100 to the printer module 200. Also the section shown by a dotted line with the reference number 500 is a sorter, which is attached optionally by the user.

Fig. 9 shows components of the second data I/O section 202. In this embodiment, control over communications with other module is provided by this second data I/O section 202. In this figure, designated at the reference number is a microprocessor (CPU), at 252 an interrupt controller (INT), at 253 a read/write memory (RAM), at 254 a read only memory (ROM), at 255 a timer counter (TMR), at 256 a DMA controller, at 257 a first-in first-out memory (FIFO), at 258 an SCSI controller, at 259 a controller for optical fiber connector s 202c, 202d, at 204a an crystal oscillator for the second synchronizing signal generating section 204, at 202BUS a bus, and at 202D, 261D an image data channel respectively. The reference

number 206 indicates an I/O circuit for such components as a sensor and a motor, while the reference number 261 indicates a driving circuit for the laser diode (laser exposure unit) 207, and both of these two circuits are connected to the bus 202BUS in the second data I/O section 202.

Also in this figure, the reference numbers 500 and 510 indicate a sorter and a multi-stage paper feeder connected to each other through the optical fiber connectors 202c, 202d.

With the system built as described above, now description is made for 1) operations of a printer module for forming an image, 2) timing control and synchronism control in the second data I/O section, and 3) other functions of the second data I/O section in this order.

1) Operations of a printer control for forming an image

The printer module 200 forms a full color visual image comprising dot patterns having the recording dot density of 1/16mm or 1/24mm based on 2-dot recording data having the pixel density of 1/16mm or 1/24mm both in the primary and secondary scanning directions for each of the CMYK colors inputted to the second data I/O section 202, and outputs the visual image on recording paper. Selection of the recording dot density of 1/16mm or 1/24mm is executed according to a mode select command. The default dot density is

1/16mm.

When an image forming cycle is started, at first the photo-sensitive drum 205 is rotated counterclockwise by the driving motor 205M, and the intermediate transfer belt 210 is rotated clockwise. Formation of a C toner image, M toner image, Y toner image, and K toner image is executed successively in association with rotation of the intermediate transfer belt 210. Finally the images are superimposed in the order of CMYK on the intermediate belt 210 to form a toner image.

For first, formation of a C toner image is executed as described below. The electrifying scorotron 206 electrifies the photo-sensitive drum 205 homogeneously with a negative voltage of -700V by means of corona electric discharge. Then the laser diode 207 executes laster exposure according to a C signal. Record signals for forming an image are provided from the scanner module 100 in the general copying mode, and from the system control module 300 in a specific copying mode including an intelligent image processing (such as an AI processing described later), or a facsimile more or a printer mode. A data request signal REQ for requesting "transfer of record image data in a specified time" to the scanner module 100 in the copying mode and to the system control module 300 in the facsimile more or the printer mode.

A record signal is inputted from the SCSI

connectors 202a, 202b in the second data I/O section 202, and the laser driving circuit 261 which is a record control circuit provides control over the laser diode 207 for light emission by input pixel. A record signal consists of two bits for one pixel. More concretely, a laser beam for the full primary scanning line width is emitted for a pixel having the highest C density, and on the contrary no laser beam is emitted to a white pixel, and also a laser beam is emitted according to a signal indicating an intermediate degree of density for a period of time proportional to the density data.

When a laster image is exposed to light as described above, in the exposed section of the light sensing drum body 205 homogeneously electrified in the initial stage, an electric charge disappears in proportion to a quantity of light to which the section was exposed, and an electrostatic latent image is formed.

Toner in the developing unit 203 is electrified to a negative polarity when mixed and agitated with ferrite carrier, and a cyan development roller in this developing unit is biased to a voltage level where a negative DC voltage and an AD voltage are superimposed against the metallic base layer of the photo-sensitive drum 205 by a power supply means not shown herein. As a result, the toner does not adhere to a section of the photo-sensitive drum 205 where an

electric charge is still remaining, while the toner adheres to a section having no electric charge, namely in the section exposed to light, and for this reason a C visual image completely similar to the latent image is formed.

Thus, when a toner image on the light sensing body drum 205 is rotated counterclockwise and reaches a position opposite to the primary transfer corotron 209, and toner image is transferred by means of corona discharge onto the intermediate transfer belt 210 which contacts the light sensing drum 205 and is driven at the same speed as that of the photo-sensitive drum. A small quantity of residual toner not transferred and remaining on the photo-sensitive drum 205 is cleaned by the cleaning unit 220 for reuse of the photo-sensitive drum 205. The recovered toner is stored in a waste toner tank through a recovery pipe.

The intermediate transfer belt 210 is made of material having a relatively specific resistance value to maintain a long time image carriage characteristics often requested in the printer mode. This feature makes it possible for a toner image to be maintained for a long time; for instance for 20 minutes until formation of the next M toner image.

Then prior to exposure of a laster image for forming an M image based on an M signal, the developing unit 208 is rotated counterclockwise, and the magenta developing unit 208M is moved so that the developing

unit 208M will face the photo-sensitive drum 205. Then a tip position of the C visual image formed before is detected by the tip detection sensor 226, and the data request signal REQ for asking "transfer of recorded M image data in a specified time" is again issued to the scanner module 100 in the copying model and to the system control module 300 in the facsimile more and the printer mode. This request signal is issued simultaneously when the tip detection sensor 226 detects a C toner mark image for registration provided a little ahead of the effective C image in the previous process and the effective C image. Also a system in which a permanent mark is put in place of the C toner mark on the intermediate transfer belt 210 is allowable.

If an M signal is received in precise synchronism to this request signal, exposure of an M image, development, and primary transfer are executed, and also accurate color print section alignment can be executed against the original C image, namely the M image is correctly superimposed on the C image on the intermediate transfer belt 210.

Thus when an M laster image is exposed to light, electric charge in proportion to a quantity of light to which the M laster image was exposed disappears in the exposed section of the photo-sensitive drum homogeneously electrified in the initial state, thus an electrostatic latent image being formed.

M toner in the developing unit 208M is electrified to a negative polarity, and the magenta development roller in this developing unit contacts the light sensing drum body 205 and is biased to a voltage similar to that in the C developing unit. As a result, the toner does not adhere to a section of the photo-sensitive drum 205 where still electric charge is remaining, while M toner adheres to a section exposed to light according to the M signal, and an M visual image similar to the electrostatic latent image is formed.

Similarly an Y image and an K image are superimposed on the CM toner image and the CMY toner image respectively. It should be noted that the basic image processing section 105 executes the UCR (under color removal) processing and for this reason 1 pixel is rarely developed with all of the 4 colors. A full-color image formed on the intermediate transfer belt 210 which rotated at least 4 times as described above is rotated and transferred to a position of the secondary transfer corotron 211.

On the other hand, at a timing when formation of an image is started, record paper is fed from any of the 3 paper feeding sections; namely the double-sided copy paper auto-feeder cassette 215, the manual paper feed tray 216, and the external paper feed port 227, and stands by at a nip of the resist roller pair 219. And the resist roller pair is driven so that a tip of

the recording paper coincides with a tip of this image when a tip of a toner image on the intermediate transfer belt 210 is passing by the secondary transfer corotron 211, thus registration alignment between the recording paper and the image being carried out.

Thus the recording paper superimposed on an image on the intermediate belt 210 passes under the secondary transfer corotron 211 connected to a positive voltage power supply unit. Then the recording paper is electrified to a positive electric charge by the corona discharge current, and most of the toner image is transferred to the recording paper. Then, when the recording paper passes over the charge removing core (not shown) provided a little to the left side from the secondary corotron 211 and connected to an earthing source, the recording paper discharge the electric charge, and most of the absorbing force between the intermediate transfer belt and the recording force disappears. Then the tare weight of recording paper becomes larger than the absorbing force, when the recording paper goes off from the intermediate transfer belt 210 and removes to the transfer belt 221.

The recording paper with a toner image thereon is transferred by the transfer belt 221 to a fixing position (the fixing roller 222 and the fixing back-up roller 223). Then heat and pressure are applied to the recording paper at a nip section between the heated fixing roller 222 and the fixing back-up

roller, and the toner is melt down and goes into between fibers of the recording paper, thus the image being fixed. Namely, a copy image is completed. The complete copy image passes through the paper discharge roller 224 and is sent out of the copying system. The discharged paper is stacked on a tray not shown herein with the copied surface upward.

When images are to be copied on both surfaces of the recording paper, the switch roller 225 is moved together with a paper deflector and is pressed to the opposite transfer roller to turn over the recording paper once, and then the recording paper is led to the double-sided copy paper auto-feed cassette by the transfer roller 215H. Then the copied recording paper is stacked on the tray with the copied surface upward.

2) Timing control and synchronism control for second data I/O section

The second data I/O section 202 communicates with the system control module 300 or the scanner module 100 according to a specified protocol, obtains image data basically by main scanning line, forms an image by coordinating, energizing and controlling all of the means inside the module according to the instructed print mode, and outputs the final image (onto the recording paper). Also the developing unit 208 controls option devices, such as a sorter, optionally added to the printer module 200.

In the color print mode, CMYK color images are formed one by one, the images are superimposed on the intermediate transfer belt 210, and the resultant image is transferred as a final image onto the recording paper. For this reason, in the color copy mode, a scan request is issued 4 times for one sheet of print to the system control module 300 or the scanner module 100. When forming a color image, it is very important to insure positional accuracy (correct registration) for each color print section on the intermediate transfer belt, and the system required for achieving the object is shown in Fig. 10.

Fig. 10 shows an example of timing control for the printer module 200 to illustrate synchronization of image signals for one time. In the system shown in Fig. 10, a data request command REQ is sent to the system control module 300 or the scanner module 100 by a specified time t5 before reception of the image data. When forming a color image, in forming the second or the subsequent color print sections, the data request signal REQ may be issued by the time t5 before the tip of the previous color image reaches the exposure point 207X. In order to accurately measure the time required for a tip of the previous color print section to reach the exposure point 207X, the image tip detection sensor is provided at a position opposite to the intermediate transfer belt 210. Basically a value obtained by adding a product of the photo-sensitive

body's circumferential speed Vpc with t5 to the range L1 from the exposure point 207X to the primary transfer point 209T is coincided with the range L2 from the primary transfer point 209T to a detecting position of the image tip detection sensor 226, in forming the second and subsequent color print sections, the tip reference image of the color image formed in the previous step is detected, and a data request signal REQ is issued simultaneously when the tip reference image is detected.

This type of system in which a data request signal is issued by a specified time before is especially useful for a data source having a data receiving side with a scanning device having a weight such as the scanner module 100 and requiring a certain period of time for preparation until start of image data output.

By issuing the data request command as described above, the data generating side is always ready for sending data for the first scanning line in the time t5 according to the inter-module protocol, as described in relation to the scanner module 100. With this feature, at least synchronism concerning phase is maintained.

Next to establish synchronism concerning cycle, in the copying system according to the present invention, at first record data for one scanning line is received from the data sending side in synchronism

to the cycle ts2 of pulse series generated from the second synchronizing signal generating section 204, and the received data is inputted in the FIFO 257 which is a receiving buffer. Also the rotary multi-faced mirror is driven in synchronism to this pulse series cycle ts2. Concretely, the rotary multi-faced mirror 213 is driven by a phase lock servo and the mirror face changes to a new one at the cycle ts2. With this feature, the exposure point 207X of the laser diode 207 emits light and scans the photo-sensitive drum 205 at the cycle of ts2. Also it is needless to say that, during light emission and scanning, the laser driving circuit 261 drives and turns ON the laser diode 207 4752 times for each pixel according to the image data D1 to D4752 (Refer to Fig. 10). In the copy mode, the data sending side is the scanner module 100, so that the synchronizing mechanism described above can be maintained. For this reason, even if a manuscript is scanned many times, image data is obtained in a constant period of time after the command is sent, a correct positional relation (registration) between recording paper and an image is always maintained, and correct registration of color print sections is maintained.

3) Other functions of the second data I/O section

Fig. 11 is a flow chart illustrating other functions of the second data I/O section 202. These

functions are executed by running a program for the microprocessor 251 shown in Fig. 9. The program to be run is stored in the read only memory 254. S201 indicates a step to turn ON the power switch 203b, while S202 indicates a processing for initialization including setting initial parameters for various types of circuit element, watch dog timer start, and initial positioning of 4-color developing unit 208.

S203 is a step to make a determination as to whether a command from the SCSI connectors 202a, 202b has come in within a specified period of time (time-out time) or not.

S204 is a function to disconnect a power for a heater in a fixing unit, which is useful for power reduction in the stand-by mode.

S205 indicates a function generated when the watch dog timer is off from normal execution of the program, and then the fault generation alert function alerts watch dog time out to the system control module 300.

S210 indicates interrupt vectoring when a fault is generated in the image forming section 201 or in other modules in this system, S211 indicates a step to makes a determination as to whether any fault has occurred or not, S211 indicates a step to identify a faulty section and make analysis for cause of the fault, S213 indicates a step to alert generation of a fault to the system control module 300, and S214

indicates a step to execute a fail-safe processing for evading such troubles as fire, for instance, when the motor 205M goes wrong due to over heating.

S220 indicates interrupt vectoring when any data is inputted to the SCSI connectors 202a,202b, and then operation of the sleep timer is stopped in the step S221. S222 indicates a step to check contents of received data and branch to any of the following 5 types of operation.

At first, in TEST (TEST unit ready) in S230, this printer module is a route for making an inquiry as to whether formation of an image is possible or not, and a reply concerning status of the scanner module 100 including option devices 500, 510 is given in S231.

S240 is the SENS (mode SENSe) step to make an inquiry as to various types of mode set up in the printer module 200, and a reply concerning the set-up mode in the printer module 200 including option devices 500, 510 is given in the steps S241 to S245.

S250 is a path for sending the SEL (mode SELect) request concerning various types of mode to be set up, forming a pair with the SENS. Various parameters are set up in each routine from S251 to S256.

S260 is a path for issuing the PRINT request, and this request is issued once for 1 print in the ordinary monochrome image forming process, 4 times in the color processing, and 2 times successively in the

secondary color monochrome processing. When issuing this request, at first the motor 205M is activated in the step S261, then an image formation sequence control is started in the step S262, and an operation for detection by the tip detection sensor 226 is monitored in S263. When the sensor 226 detects a tip of an image, a data request signal REQ is immediately issued. Also, the line counter (scanning line counter) provided in the memory 253 is reset in S265. This counter is incremented by 1 according to a synchronizing pulse which the second synchronizing signal generating section 204 generates once to 1 scanning line.

S266 indicates a task to monitor a time since a data request signal REQ is issued until the data sensing side becomes ready for transmitting the data in the first line, in other words a task to monitor a time, if another color image exists already, until the image rotates and returns to the exposure position 207X. When this time has passed, the line counter is reset for the second time in S267, and furthermore an exit gate of the FIFO 257 which is a buffer memory for image data is opened to prepare for delivery of a record image signal through the image signal line 261D to the laser driver 261.

S268 to S272 are a group of tasks to store image data sent from the SCSI connectors 202a, 202b by one scan line in the FIFO 257, and at first a

synchronizing pulse which the second synchronizing signal generating section 204 generates once for 1 scanning line is detected in S268. S269 indicates a step to store record image data for 4752 pixels for 1 scanning line in the FIFO 257. Then the line counter is incremented in S270.

The loop in S271 is equivalent to a record size, and for instance scanning is repeated for 6720 scanning lines (namely 6720 times) in case of A3 size paper. When scanning with a laser for one page is finished, the exit gate of the FIFO 257 is closed in S273, and a laser drive signal is disconnected. It is needless to say that also the work to receive record image data from the SCSI connectors 202a, 202b is finished at this point of time.

S274 indicates a step to check whether the last operation of form an image was the final operation for forming a final color image of the final record image or not. If it is not the final color image, the remaining sequence control for forming images is forcefully finished, and the motor is stopped in S280. If formation of the final color image is complete, the processes of paper feeding, secondary transfer, fixing and paper discharging in S274 to S278 are executed, and the record image (recording paper) is discharged to outside of the printer module 200.

S290 indicates a route for self diagnosis DIAG (DIAGnostic) when required to the printer module

200, and self diagnosis is typically required after the fault generation alert function (in S206 and S212 above) alerts generation of a fault, and the self diagnosis and reply to the request are executed in S291 to S293.

[Configuration and operations of the system control module]

Fig. 12 is a block diagram illustrating basic functional sections of the system control module 300. Fig. 13 is an organization chart of the system control module 300. The system control module 300 is largely divided to the third data I/O section 301 having SCSI connectors 310a, 301b which is an I/O interface for image data as well as for various types of control data, a system control section 302 which issues a command to run the scanner module 100 and the printer module 200 synchronously, a console 303 having a key input section 303a and a bit map display section 303b, an electrophoto-magnetic memory or a CD-ROM drive unit 304, a floppy disk device 305, an IC card drive unit 306, an interface 307 for connection to a host computer or other components, an interface 308 for connection to the public network, and a accelerating device 309. It should be noted that the system control section 302 comprises a copy processing section 302a, a facsimile processing section 302b, a print processing section 302c, and an intelligent image processing section 302d.

All of these functional sections are packaged in the system control module 300. Also the mechanism can be connected to the upper section of the printer module 200 with a connecting means.

As shown in Fig. 13, an operating panel of the console 303 is exposed upward and is provided in the front side so that the console can be operated when the scanner module 100 is placed on it. Also the electrophoto-magnetic memory or the CD-ROM drive unit 304, a floppy disk device 305, and the IC card drive unit 306 are provided at the back of the SCSI connectors 301a, 301b of the third data I/O section 301. It should be noted that recording medium driving means such as the electrophoto-magnetic device or the CD-ROM drive unit 304, the floppy disk device 305, and the IC card drive unit 306 are employed or not employed according to the desired system configuration and are incorporated in the system control module 300.

Fig. 14 is an explanatory view illustrating components of the third data I/O section 301. In this figure, designated at the reference numeral 351 is a microprocessor (CPU), at 352 interrupt controller (INT), at 353 a read/write memory (RAM), at 354 a read only memory (ROM), at 355 a timer counter (TMR), at 356 a third synchronizing signal generating section, at 356a an crystal oscillator of the third synchronizing signal generating section 356, at 357 a DMA controller, at 358 a first-in first-out (FIFO) memory, at 359 an

SCSI controller, at 301a and 310b an SCSI connector respectively, at 301c and 301d an optical fiber connector respectively, at 301BUS a bus, and at 301D and 309D an image data channel respectively.

Also designated at the reference number 360 a memory backed up by a battery 360a, at 310HDD a magnetic disk drive, at 304D, 305D, 306D a controller for an electrophoto-magnetic device or a CD-ROM drive unit 304, a floppy disk unit 305, and an ID card drive unit respectively.

Also designated at 303c and 303d is an interface for the key input section 303a and the bit map display section 303d respectively. In the key input section 303a are provided such components as a start key 361, a ten-key 362, an enter key 363, a cursor key 364.

With the configuration as described above, now description is made for (1) function of the third data I/O section, (2) general functions of the system control section, and (3) functions of the copy processing section of the system control section in this order.

(1) Functions of the third data I/O section

The first function of the third data I/O section 301 is to provide over at least either one or both of the scanner module 100 and the printer module 200, the second function thereof is to provide control

over the console for input to display an image, and the third function thereof is to operate a recording medium such as the electrophoto-magnetic memory or CD-ROM drive unit 304, a floppy disk unit 305, and IC card drive unit 306.

In Fig. 12, the third data I/O section 301 includes an operating system 301CORE, a library routine 301L1 - Ln, an application processing interface 310API, and a device driver 301DV. All of these functions and means make use of hardware resources in the third data I/O section 301, and are realized by means of executing a program stored in the ROM 354 or the magnetic disk drive 301HDD.

The first function of the device driver 301DV is to provide control over at least one up to 7 modules of the scanner module 100 and/or printer module 200. The second function thereof is control over the console 303 for display to a screen (display section 303b) and input from the key input section 303a. The third function thereof is to operate a recording medium such as the electrophoto-magnetic memory or CD-ROM drive unit 304, the floppy disk unit 305, or the IC card drive unit 306. These control processes are activated under multi-task real time control by the operating system 301CORE.

The application processing interface 301API is an interface means with the system control section 302, and the system control section 302 is a key for

utilization of the third data I/O section 301 as well as means and devices connected thereto.

(2) General functions of the system control section

In Fig. 12, the system control section 302 comprises the copy processing section 302a, the facsimile processing section 302b, the print processing section 302c, and the intelligent image processing section 302d. All of these processing sections share hardware resources of the third data I/O section 301, and are realized by means of executing a program stored in the magnetic disk drive 301HDD.

The copy processing section 302a is a processing means for realizing an image copying function by providing systematic controls over the entire system in a copying system in which the scanner module 100, printer module 200, and this system control module 300 are connected to each other.

The facsimile processing section 302b is a processing means for realizing a facsimile function by providing systematic controls over the entire system in a copying system in which the scanner module 100, the printer module 200, and this system control module 300 are connected to each other.

The print processing section 302c is a processing means for realizing a printer function by means of providing systematic controls over the entire system in a copying system in which the scanner module

100, the printer module 200, and this system control module 300 are connected to each other.

The intelligent image processing section 302d is a processing means for realizing an intelligent image processing function by providing systematic controls over the entire system in a copying system in which the scanner module 100, the printer module 200, and this system control module 300 are connected to each other. Herein, the intelligent image processing is defined as an image processing in which a manuscript picture and the output image are quite different such as in a case where, for instance, the scanner module 100 recognizes letters from a read image and makes up graphics based on the letters. In the intelligent image processing, different from a processing in the general copying mode, image data is once fetched into the system control section 302, the image data is processed by this intelligent image processing section 302d, then the processed image data is sent to the printer module 200, and an image is formed.

The 5 types of application processing are selected according to the system configuration and are incorporated in the system control module 300.

(3) Functions of the copying processing section in the system control section

Next more detailed description is made for functions of the copy processing section 302a in the

system control section 302 for realizing a copying function in which the scanner module 100, the printer module 200, and this system control module 300 are connected to each other. Fig. 16A and 16B are timing charts illustrating operations in the copying function, while Fig. 17 is a timing chart when a fault is generated during the copy processing function.

In Fig. 15, S301 indicates a start signal when the power switch 203b of the printer module 200 is turned ON. Herein turning ON power for the printer module 200 is referred to, because the system control module 300 is integrated with the printer module 200 and an electric power is supplied thereto from the printer module 200. In S304, power-on initialize processing including initialization of parameters on various types of software, for instance, an internal register in the interrupt controller 352.

S302 indicates time out of a watch dog timer, and in S303 a processing to protect data to be backed up, concretely a processing to save the data in the memory 360 backed up by a battery is executed, and the system operation branches to the power ON initialize processing in S304. S305 indicates a process to check for various events, while S306 indicates a process to check the contents and jump to any of 4 types of bus.

The step S310 branches when alert on generation of a fault is received from the scanner module 100 or the printer module 200, and the contents

is checked in the steps S311 to S314. S315 indicates a step to provide a display on a screen (display section 330b) so that contents of the fault will clearly been shown to an operator. Also the information is sent to a service center connected to the public line. S317 indicates a step to receive an instruction such as a sequence for overcoming the fault from said service center, and contents of the received information is displayed in the step S318.

The step S320 branches when an alert for generation of a fault is received from the scanner module 100 or the printer module 200. The fault defined herein indicates, for instance, shortage of supply such as toner or recording paper, or open door of a frame, and in the fault as defined herein the normal state can easily be restored, for instance herein, by providing supply or closing the door.

The step S330 branches when the start key 361 is pressed, and issues an inquiry as to whether the scanner module 100 and the printer module 200 are ready or not. If both the two components are ready, the COPY command is sent to the scanner module 100 in S335, and the PRINT command is sent to the printer module 200 in S336. With this operation, commands are exchanged between the scanner module 100 and the printer module 200, image data is exchanged according to the sequence described in relation to each module, and a copy is produced.

In the steps S337 to S340, an inquiry is issued as to whether a series of image read process and image forming process have been finished or not. If the initial state has been restored, the state of copy is displayed on a screen (Display section 303b). In S342, whether copying for specified color print sections or by a specified number of copies is complete or not is checked in S342, and if formation of remaining color images is still required, the system control returns to the first step (S331). In copying a color image, this loop is repeated four times.

The step S360 is activated when various types of copy modes are entered by an operator from the console 303, namely, for instance, when an image processing mode or a sorting mode is specified, and a response screen is displayed on the display section 303b in S361, and at the same the time mode set command is sent to the scanner module 110 and the printer module 200 in S363 to S363.

[Examples of combinations of modules]

Fig. 18 and Fig. 19 are organization charts each illustrating an example of system configuration in which the above-described 3 basic modules are combined, and each example shows a case in which a system useful for industrial purposes is formed respectively. In Fig. 18 and Fig. 19, a square indicates a functional section, an arrow head mainly indicates an image

signal, and solid lines 100S, 200S indicate a transfer line for control signals and image signals between the modules, namely the SCSI cable.

Fig. 18A shows so-called the scanner device simply comprising the scanner module 100, in which the SCSI connector 102a (or 102b) of the first data I/O section 102 is connected to a host computer HOST, and the first data I/O section 102 directly communicates with the host computer HOST to deliver read image data.

Fig. 18B shows so-called to bit-map laser printer comprising the printer module 200 as a single body. Then the SCSI connector 202b (or 102b) of the second data I/O section 202 directly communicates with the host computer HOST to obtain image data from the host computer HOST, and forms a hard copy.

Fig. 18C shows an example of system configuration as a general copying machine, and this system configuration can be realized by connecting one unit of the scanner module 100, the printer module 200, and the system control module 300 respectively to each other. In this system control module 300 is incorporated the copy processing section 302a to realize a copying function by systematically controlling the scanner module 100 and the printer module 200.

Fig. 19A shows a triple read copying machine, and in each of the copying section are connected a first scanner module 100A, a second scanner module

100B, a third scanner module 100C, the printer module 200, and the system control module 300 respectively. Herein, if the first scanner module 100A is a general scanner module for, for instance, A3 recording paper, the second scanner module 100B is a large size scanner module for, for instance, A1 recording paper, and the third scanner module 100C is a color scanner module, various merits are provided as compared to a case where copying machines each dedicated to a special size of recording paper as well as to color copy are installed. Also a combination of these components and a number of components combined can freely be changed according to the necessity. In the system control module 300 is incorporated a multiple read copy processing section (not shown) for realizing a copying function by systematically controlling the above 4 modules.

Although not shown herein, a system can comprise a plurality of printing modules 200. In this case, a multiple record/copy processing section for realizing a copying function by systematically controlling other modules is incorporated in the system control module 300. Also in this copying system, up to 7 units of the scanner module 100 and the printer module 210 can be connected as a multiple system.

Fig. 19B shows a copy/high performance printer/color facsimile hybrid system comprising the scanner module 100, the printer module 200, and the

system control module 300, and in the system control module 300 are incorporated the interface for connection to the host computer HOST, a printer processing section 302c for converting print data in a page description language format received from the interface 307 to laster data, an interface 308 for connection to the public line ISDN, and a color facsimile processing section 302b for extending data in a specified compression format received from said interface 308 and compressing image data read by the scanner module 100 into a specified format.

[An example of concrete configuration of the copying system]

Fig. 20 shows a concrete example of system configuration in which the basic modules are assembled into a copying system. Fig. 21 is an explanatory view illustrating functional sections of and a signal flow in the concrete example shown in Fig. 20. Description is made hereinafter for the functional sections and the signal flow with reference to these figures.

This is a more sophisticated example of the copying system shown in Fig. 18C with an automatic manuscript feeder 400 and a film projector 410 each as an option device added to the canner module 100. Also a multi-stage paper feeder 510 and a sorter 500 are added to the printer module 200.

A section drawn with a broken line in Fig. 21

indicates optional functions, which can be added to the system control module 300 in the copying system already installed at a user's site, and if all of these operational functions are added, the same copying system as shown in Fig. 19B is obtained.

Fig. 22 is an explanatory view illustrating timing of operation for copying a color image in the copying system shown in Fig. 20. In this figure, the reference numerals 300, 100, and 200 indicate operation of a system control module, a scanner module, and a printer module respectively, and signs C, P and R in the box indicate COPY, PRINT, and REQ signals (commands) respectively.

When a first COPY command is issued from the system control module 300 to the scanner module 100, the scanner module 100transfer the command as a RPINT signal to the printer module 200. When the printer module 200 receives the signal, the image tip detection sensor 226 in the printer module 200 detects an image tip mark drawn on the intermediate transfer belt 210, and immediately the second synchronizing signal generating section 204 sends the result of detection as a record data request signal REQ to the scanner module 100, at the same time resets and activates the line counter, and waits until the prespecified time t5 up to start of operation passes. On the other hand, the scanner module 100 having received the data request signal REQ provides control over acceleration of the

first carriage 109 so that the timing is adjusted to the prespecified time t5 up to start of manuscript picture reading.

Then, when the time t5 has passed, the first carriage 109 of the scanner module 100 goes up to the image tip 108S, and a position of the photo-sensitive drum 205 corresponding to the image tip position to be exposed to light comes on the light axis for exposure 209T. From this point of time, the scanner module 100 outputs image signals D1 to D4752 for each scanning line, while the printer module 200 receives the image signals D1 to D4752 for each scanning line, and forms an image by exposing these to light.

A central section of Fig. 22 shows in detail the situation after start of synchronizing image signal transaction when the image on the 9th line is being read. In this figure, the FIFO 157 which is an image buffer for 4 scanning lines incorporated in the scanner module 100 and the FIFO 257 which is an image buffer for 2 scanning lines incorporated in the printer module 200 are provided, so that is a time delay for totally 6 scanning lines between the timing for reading and the timing for recording. This time lag generates backward displacement by around 0.4mm of phase in forming a copy image. However, the phase difference is always constant, so that displacement between color print sections will never occur. For practical purpose, this generates an error in registration of recording paper,

although the error is a very small one. However, this problem can be solved by taking such measures as delaying the timing for recording paper feed and secondary transfer by 6 scanning lines, and an accurate registration of recording paper can be insured.

It should be noted that a memory capacity of the FIFO 147 in the scanner module 100 is set for 4 scanning lines and that of the FIFO 257 in the printer module 200 for 2 scanning lines because a slight dispersion exists in the actual crystal oscillators 104a and 204a and this diversion must be compensated. More in detail, the effect is expected that, even if a frequency of the crystal oscillator 104a is slightly higher than that of the crystal oscillator 204a, such troubles as skipping data to be read or overflow will never occur provided that the difference, when converted to the line synchronizing frequency and furthermore to a number of scanning lines, is in a range from 6720 lines to 6722 lines with the standard number of scanning lines of 6720 as the center.

When the above process is over, an image for one color is formed on the intermediate transfer belt 210. By repeating this process 4 times (namely for 4 colors), the synchronizing sequence described above is executed, and a color image without no color registration error is formed on the intermediate transfer belt 210. The final color image can be obtained by transferring the color image above to the

recording paper 190, fixing it thereon, and discharging the recording paper.

In the embodiment described above, the system control module 300 integrated with the printer module 200issues a manuscript picture scan command to the scanner module 100, and an image form command to the printer module 200. According to the commands, the printer module 200 synchronizes to detecting operation of the image tip detection sensor 226 and issues a record data request signal to the scanner module 100, and the scanner module 100 outputs image data read by resolving the manuscript image into pixels in the specified period of time t5 after said request signal is received to the printer module 200. On the other hand, the printer module 200 having issued the store data request signal starts receiving record image data delayed by the specified period of time t5 from the timing for starting detection of the image tip. With this scheme, at least registration of image tip to recording paper and registration of color image color print section tip can be maintained.

Furthermore the scanner module 100 generates a image signal for each scanning line synchronizing to a signal generated by the first synchronizing signal generating section 104, while the printer module 200 forms an image by each scanning line synchronizing to a signal generated by the second synchronizing signal generating section, and by synchronizing the

synchronizing signal generated by the first synchronizing signal generating section 104 to the synchronizing signal generated by the second synchronizing signal generating section, it becomes possible, without using a buffer memory, that a size of a copy image accurately coincides with that of the manuscript picture and color print sections are accurately aligned from the tip to read edge of each color image when forming a color image.

Fig. 23 is a block diagram showing other basic components of the copying system shown in Fig. 1, and a difference of the copying system shown in this figure from that shown in Fig. 1 is that the first electric power supply section 103 in the scanner module 100 has been eliminated and power to said scanner module 100 is supplied through a cable from the electric power supply section 203a in the printer module 200. With this configuration, a number of parts used in the entire system can be reduced, and the product cost can be reduced.

Fig. 24 and Fig. 25 are explanatory views each illustrating a data transfer system between each module, and Fig. 24 shows a data transfer system using light, while Fig. 25 shows a data transfer system using electric waves. In Fig. 24, in the scanner module 100 are provided a light emitting element 500 (such as a light emitting diode, or a laser diode) for transmitting optical data, a lens 501 connected to said

light emitting element 500, a light receiving element (such as a photo diode) for receiving optical data, and a lens 503 connected to said light receiving element 502. Also in the printer module 200 are provided a light emitting element 517 for transmitting optical data, a lens 517 connected to said light receiving element 517, a light receiving element 515 for receiving optical data, and a lens 514 connected to said light receiving element 515.

Furthermore in the system control module 300 are provided a light emitting element 509 for transmitting optical data for the scanner module 100 mounted on said system control module 300, a light receiving element 507 for receiving optical data, and a lens 506 connected to said light receiving element 507, and also are provided therein a light emitting element 510 for returning optical data for the printer module 200 mounted under said system control module, a lens 511 connected to said light emitting element 510, a light receiving element 512 for receiving the optical data, and a lens 513 connected to said light receiving element 512.

The reference numeral 504 indicates an arraying means, a convex section and a concave section are provided in modules positioned in the vertical direction respectively, and each module is fixed at a specified position by engaging the convex and concave sections respectively. So that the optical axis for

light emission and that for light receiving will coincide with each other in said arraying means, it is preferable to widen an allowance for alignment in practical systems, and to convert a light beam to a parallel light flux having, for instance, a width of around 5mm, beam expander lenses are preferably used for the lenses 501, 508, 511, and 516 each in the light emitting side, and condenser lenses are used for the lenses 503, 506, 513, and 514 each in the light receiving side to efficiently focus the receiving light into the light receiving element. It should be noted that the reference numeral 505 indicates a space through which optical data is transferred.

In Fig. 25, the reference numerals 600, 604 indicates an antenna for transmission respectively, the reference numerals 601, 602 indicates an antenna for receiving respectively, and the reference numeral 603 indicates a space for transmission of electric waves. When transmitting electric waves in a full-duplexed communication system, antennas 600, 601, 602, 604 each available for both transmission and receiving are provided to transmit and receive signals simultaneously. If an electric wave transfer path for the first pair is too close to an electric wave transfer path for the second pair, interference may be generated if the carrier for each path has the same frequency, but in this case the interference can be prevented by using a carrier having a different

frequency for each path, such as 350MHz and 450MHz, or by employing the system configuration in which the frequency is the same but the plane of polarization of each carrier crosses each other at right angles. Also the system configuration in which each carrier has the same frequency but the electric wave paths for the first pair and the second pair are sealed with appropriate material such as metal is allowable.

Also in a half-duplexed communication system, antennas for transmitting and receiving electric waves can be shared, and in that case signals are transmitted and received in a time-division system like in the SCSI system. Also a ultrasonic system may be employed.

Fig. 26A, Fig. 26B, and Fig. 27 show other embodiments of the arraying means described above, and in Fig. 26 the frames 700, 701 for the modules piled up in the vertical direction are fixed and arrayed with a screw 702. In Fig. 27, the frame 701 for other module and the frame 700 for the module are arrayed and fixed with a hook 801 provided in the frame 700 for the module.

Also data is transmitted and received through a space by means of light, electric waves, and supersonic waves, using the arraying means, and without using any member for connection such as a cable, so that the workability in setting each module can remarkably be improved.

Although the invention has been described

with respect to a specific embodiment for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art which fairly fall within the basic teaching herein set forth.